

STANDARD SPECIFICATIONS  
FOR THE DESIGN AND FABRICATION OF  
**STRUCTURAL GLUED  
LAMINATED SOUTHERN PINE**



# SOUTHERN PINE

SOUTHERN PINE ASSOCIATION • NEW ORLEANS, LOUISIANA

# F O R E W O R D

These specifications for structural glued laminated Southern Pine are based on extensive research and technical experience. The specifications, including the working stresses, conform to the recommendations of the Forest Products Laboratory of the United States Department of Agriculture at Madison, Wisconsin.

Acknowledgment is made to the Forest Products Laboratory for the basic data and the special study, which it conducted on the use of standard grades of Southern Pine in structural glued laminated lumber. The assistance of engineers at the Forest Products Laboratory in the preparation of these specifications also is acknowledged.



# ARCHITECTS' GUIDE TO SPECIFICATIONS FOR GLUED LAMINATED STRUCTURAL LUMBER IN STRUCTURAL MEMBERS SUCH AS ARCHES, BEAMS, TRUSSES AND COLUMNS

## 1. *Fabrication*

Structural glued laminated members shall be fabricated in accordance with the Standard Specifications for Structural Glued Laminated Southern Pine (Hereinafter referred to as the Standard Specifications) adopted by the Southern Pine Inspection Bureau, January, 1954. The fabricator shall have plant facilities, equipment, and personnel capable of meeting the requirements of the Standard Specifications.

## 2. *Materials*

- a. **Lumber** — The laminating lumber shall be kiln dried Southern Pine of grades or combinations of grades as listed in the tables of stresses of the Standard Specifications to provide working stresses for design as follows:

*Stress in extreme fiber (bending).....	"f"	_____
Tension parallel to grain.....	"t"	_____
Compression parallel to grain.....	"c"	_____
Shear parallel to grain.....	"H"	_____
Compression perpendicular to grain.....	"c <sub>⊥</sub> "	_____
Modulus of elasticity.....	"E"	_____

The visible outer lamination shall be selected for clearness, uniformity of grain, and other appearance characteristics. (This provision required only where the appearance of the exposed face is important.)

- b. **Adhesives** — Laminating adhesives shall meet the requirements of the Standard Specifications for (state whether interior or exterior service—see Par. 32-37).

## 3. *Design*

Members shall be designed by a qualified structural engineer to meet the requirements of applicable building codes, ordinances, or other applicable regulations. The provision of the Standard Specifications relating to design shall be complied with. The fabricator shall furnish a complete shop drawing showing necessary details and shall obtain the Architect's approval before beginning fabrication. Design loading and maximum stresses shall be indicated on the shop drawings submitted. Type of stress for which each member is designed shall be indicated by designer so that required grain slope can be determined.

## 4. *Hardware*

The fabricator shall furnish the base and crown connections required for arches and shall furnish also the bolts required for their use except for anchor bolts embedded in concrete.

## 5. *Finishing*

Exposed faces of members shall be planed smooth. For finished work the faces shall also be sanded, stained, and finished as directed in the Architect's specifications.

## 6. *Shipping*

Complete members shall be protected during shipments from marring or other damage which would impair their utility or appearance. If conditions warrant, each member shall be individually enclosed in a moisture resistant wrapping or coating.

\* A suggested combination of stresses suitable for most designs follows:

Stress in extreme fiber.....	"f"	.....2400 #
Tension parallel to grain.....	"t"	.....2600 #
Compression parallel to grain.....	"c"	.....2000 #
Shear.....	"H"	..... 200 #
Compression perpendicular to grain.....	"c <sub>⊥</sub> "	..... 385 #
Modulus of elasticity.....	"E"	.....1,800,000 #

# \*STANDARD SPECIFICATIONS for STRUCTURAL GLUED LAMINATED SOUTHERN PINE

## General

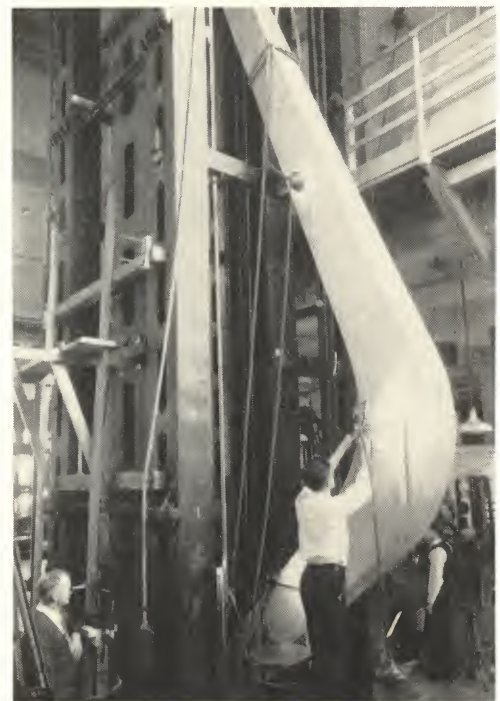
1. Structural glued laminated lumber is any stress-rated member comprising an assembly of specially selected and prepared wood laminations in which the grain of all laminations is approximately parallel longitudinally and in which the laminations are securely bonded with adhesives. The special selection, preparation, assembling and bonding of the laminations shall be in accordance with the provisions of these rules.
2. Structural glued laminated lumber shall be designed, fabricated and graded by the basic provisions used for solid sawn wood members with such modifications as are hereinafter specified.
3. Laminations shall be arranged horizontally (wide faces of laminations placed normal to the direction of load) in members stressed principally in bending, except as otherwise specified and under conditions as hereinafter provided.

## Working Stresses

4. **Dry Conditions of Use:** The working stresses in Table 1 are applicable to all normal conditions of loading and to conditions of use where the moisture content in service is less than 15 percent, as in most covered structures.

**Wet Conditions of Use:** The working stresses in Table 2 are applicable to all normal conditions of loading and to conditions of use where the moisture content in service is 15 percent or more, as may occur in exterior construction.

5. The working stresses in Tables 1 and 2, and the modifications required for other conditions of loading, are applicable also to structural glued laminated lumber that has been pressure impregnated by an approved process and preservative.
6. These standard specifications are based on the allowable unit stresses shown in Tables 1 and 2, but working stresses more or less than those tabulated may be obtained by appropriately modifying requirements as to grade combinations, slope of grain, slope of scarf joints, kind of joints, spacing of joints, and other provisions.
7. Any purchase specification predicated on a stress level that is common to dry and wet conditions of use without indicating the applicable basis shall be interpreted as being based on dry conditions of use.



Strength Tests—Southern Pine laminated arch rib.

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\* Established April 17, 1951 by Southern Pine Inspection Bureau, New Orleans.  
Revised January 19, 1954.



### *Sizes for Laminations*

8. Individual laminations shall be 2 inches net or less in thickness.
9. To the extent that practical considerations will permit, all laminations of each individual member shall be of the same uniform thickness. When laminations of different thicknesses are used, divide the depth of the member by the thickness of the thickest lamination used and then assume the quotient to be the number of laminations in the member in determining the allowable stress.
10. A lamination for a wide member may consist of two or more pieces of lumber placed side by side provided that all longitudinal joints in adjacent laminations are staggered at least two inches laterally.
11. For exterior use, face laminations of a member shall be of one piece in width, or of pieces pre-glued together edgewise.

### *Grade Provisions*

12. All lumber used as laminations in the fabrication of structural glued laminated lumber shall be graded in accordance with the current Standard Grading Rules of the Southern Pine Inspection Bureau and with the additional requirements as herein specified.



One of first American applications. Southern Pine laminated arches at Forest Products Laboratory — 1935.

13. The lumber used for laminations shall be uniformly manufactured and shall be of the grade or grades required by Tables 1 and 2, except as modified herein.

14. Each lamination shall be graded either as strips and boards or as dimension, according to its finished thickness. Laminations if  $1\frac{1}{2}$  inches thick or less shall be graded as strips and boards, and if over  $1\frac{1}{2}$  inches shall be graded as dimension.

15. Where the inner group of laminations is required to be dense, the outer group of laminations shall also be required to be dense.

16. Surfaces of laminations to be glued shall be clean and shall be free from oil, dust, and other foreign matter which will be detrimental to satisfactory gluing.
17. Laminations shall be machine finished, but not sanded, to a smooth surface and to a uniform thickness with a maximum allowable variation of  $1/64$  of an inch.
18. Warp, twist or other characteristics which will prevent intimate contact of adjacent glued faces or interfere with uniform bending to the required curvature when under clamping pressure shall not be permitted.
19. When lumber to be used for laminating is resawn, the finished resawn size shall meet the grade requirements.

### *Slope of Grain*

20. Slope of grain shall be limited in the full length of each lamination and shall be measured over a distance sufficiently great to determine the general slope, disregarding local deviations.

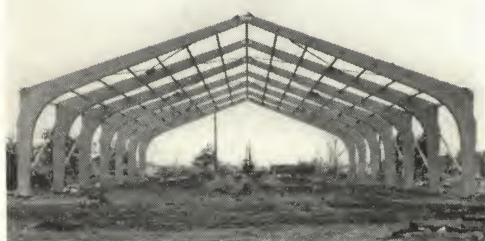


80 ft. span arch for modern super market.



## ***Slope of Grain*** — Continued

21. The slope of grain requirements for a member stressed principally in bending apply only to the laminations in the outer 10 per cent of the depth of each face, but for a tension or compression member the requirements apply to all laminations.



Recreation Auditorium—85 ft. arch span

22. Slope of grain shall be limited for bending stress as indicated in Tables 1 and 2, except for members specified as being stressed principally in compression or tension, in which case the limitations shall apply as indicated for compression or tension stress, as the case may be.
23. Slope of grain for the laminations of tapered members shall be measured with respect to the neutral axis of the member, but slope of grain does

not have to be restricted in the portion of cross section that is not considered in the design of the member, such as usually occurs in built-up haunches.

## ***End Joints***

24. The endwise joining of two or more pieces that are to comprise a single lamination shall be accomplished by scarf joints unless butt joints or other means of joining are specifically authorized.
25. Scarf joints shall be made with plain-sloping scarfs, unless otherwise specified.
26. Scarf joints shall be adequately made, accurately fitted and effectively glued to avoid the necessity of reducing the moment of inertia or effective cross section.
27. Scarf joints shall be well scattered for all members.
28. Stepped scarf joints if specified may be used the same as plain scarf joints, subject to modification stated in Par. i, Appendix A.
29. Butt joints if specified for the compression or tension portion of a member stressed principally in bending, or for a member stressed principally in compression shall not be spaced closer together in adjacent laminations than ten times the thickness of the lamination. (See design provisions Par. j and k, Appendix A.)

## ***Moisture Content***

30. The lamination at the time of gluing shall be conditioned to a moisture content approximating what it will attain in service, but shall be not less than 7 nor more than 16 per cent.
31. The range of moisture content of various laminations assembled into a single member shall not exceed 5 per cent at the time of gluing. For example, the range can be from 8 per cent to 12 per cent, inclusive, or 10 per cent to 14 per cent, inclusive, etc.

## ***Adhesives***

32. Approved adhesives shall be those which have been acceptably certified as performing satisfactorily for the uses hereinafter described and as meeting tests for durability in conformance with the latest available procedure



School Auditorium — Providing sufficient clearance height over playing area with low sidewalls.



## Adhesives — Continued

developed by the Forest Products Laboratory, U. S. Department of Agriculture, Madison, Wisconsin.

33. Interior type adhesives are recommended for interior conditions of service as in most covered structures and shall be allowed under purchase specifications that do not provide otherwise. Such adhesives shall comply with the requirements of the following:
  - (a) Federal Specification C-G-456 for casein glue.
34. Exterior type adhesives shall be required only if specified, due to the fact that their use is necessary only for exterior and submerged conditions of use.
35. If an exterior type adhesive is specified without requiring a particular type, the adhesive used shall comply with the requirements of one of the following:
  - (a) Joint Military Specification JAN-A-397 for room and intermediate temperature setting resin glue of the phenol, resorcinol or melamine type, as amended.
  - (b) Joint Military Specification MIL-A-5534 for high temperature setting resin glue of the phenol, resorcinol or melamine type, as amended.
36. Mixing, spreading, storage life, pot life, working life and assembly life shall be accordance with the manufacturer's recommendations.
37. Each lot number of adhesives shall be certified as conforming to the applicable specification.



Churches of graceful lines. Functional three-hinged laminated arches transmit all roof loads to foundation.

## Fabrication

38. Fabrication shall be in accordance with the best practices, with adequate plant and equipment, and under the supervision of properly qualified personnel.
39. The fabricator shall provide adequate facilities and equipment so that laminations are prepared, selected, spread, laid up, clamped and set within the adhesive manufacturer's specified time limits.
40. The clamping time and curing processes required for the setting of adhesives shall be in accordance with the adhesive manufacturer's recommendations.
41. Gluing pressure shall be at least 100 pounds per square inch and the minimum pressure shall assure close contact of the wood surfaces and provide a uniform thin glue line. Such conditions must be maintained until the adhesive has set.
42. Clamping methods shall be such that the pressure is as uniform as practicable over the whole area.



22 ft. laminated rigid frames for classroom construction.

## WORKING STRESSES FOR STRUCTURAL

**Table 1.**—Working stresses for dry conditions of use. (See Appendix A for modifications required when conditions of load

Combination Number	Grade of Laminations Each Side *	Number of Laminations Each Side	Grade of Inner Laminations	BENDING "f"						4-1
				4-14 Laminations			15 or more Laminations			
				Working Stress	Steepest Grain Sl.	Steepest Scarf Sl.	Working Stress	Steepest Grain Sl.	Steepest Scarf Sl.	
1-1	No. 1 Dense	All	No. 1 Dense	3000	1:18	1:12	3000	1:18	1:12	3000
1-2	B&B Dense	1	No. 1	3000	1:18	1:12	3000	1:18	1:12	2600
1-3	No. 1 Dense	1/14 of total	No. 1	3000	1:18	1:12	3000	1:18	1:12	2600
1-4	B&B Dense	1	No. 2 Dense	2800	1:16	1:10	2800	1:16	1:10	3000
1-5	No. 1 Dense	1/5 of total	No. 2 Dense	2800	1:16	1:10	3000	1:18	1:12	2800
1-6	No. 1	All	No. 1	2600	1:18	1:12	2600	1:18	1:12	2600
1-7	B&B Dense	1/14 of total	No. 2	2400	1:16	1:10	2800	1:18	1:12	2600
1-8	B&B	1	No. 2	2400	1:16	1:10	2400	1:16	1:10	2600
1-9	No. 1	1/5 of total	No. 2	2400	1:16	1:10	2600	1:18	1:12	2400
1-10	No. 2 Dense	All	No. 2 Dense	2000	1:10	1:5	2600	1:14	1:8	2600
1-11	No. 2 Dense	1/14 of total	No. 2	2000	1:10	1:5	2600	1:14	1:8	2200
1-12	No. 2	All	No. 2	1800	1:10	1:5	2200	1:14	1:8	2200

**Table 2.**—Working stresses for wet conditions of use. (See Appendix A for modifications required when conditions of load

Combination Number	Grade of Laminations Each Side *	Number of Laminations Each Side	Grade of Inner Laminations	BENDING “f”						4-1
				4-14 Laminations			15 or more Laminations			
				Working Stress	Steepest Grain Sl.	Steepest Scarf Sl.	Working Stress	Steepest Grain Sl.	Steepest Scarf Sl.	
2-1	No. 1 Dense	All	No. 1 Dense	2400	1:18	1:12	2400	1:18	1:12	2400
2-2	B&B Dense	1	No. 1	2400	1:18	1:12	2400	1:18	1:12	2000
2-3	No. 1 Dense	1/14 of total	No. 1	2400	1:18	1:12	2400	1:18	1:12	2000
2-4	B&B Dense	1	No. 2 Dense	2200	1:16	1:10	2200	1:16	1:10	2400
2-5	No. 1 Dense	1/5 of total	No. 2 Dense	2200	1:16	1:10	2400	1:18	1:12	2200
2-6	No. 1	All	No. 1	2000	1:18	1:12	2000	1:18	1:12	2000
2-7	B&B Dense	1/14 of total	No. 2	1800	1:14	1:8	2200	1:18	1:12	2000
2-8	B&B	1	No. 2	1800	1:14	1:8	2000	1:18	1:12	2000
2-9	No. 1	1/5 of total	No. 2	2000	1:18	1:12	2000	1:18	1:12	2000
2-10	No. 2 Dense	All	No. 2 Dense	1600	1:10	1:5	2000	1:14	1:8	2000
2-11	No. 2 Dense	1/14 of total	No. 2	1600	1:10	1:5	2000	1:14	1:8	1800
2-12	No. 2	All	No. 2	1400	1:10	1:5	1800	1:14	1:8	1800

\*—In grade combinations 1-1, 1-6, 2-1 and 2-6, no provision has been made for use of B&B grade in outer laminations because of appearance, it should be particularly specified, keeping in mind that B&B Dense is required when inner laminations are dense.



# GLUED LAMINATED SOUTHERN PINE

(are not normal.)

TENSION "t"					Compression Parallel to Grain "c"				Working Stress Shear Parallel to grain "H"	Working Stress Compression Perpendicular to grain "cL"	Modulus of Elasticity "E"
Laminations		15 or more Laminations			4-14 Laminations		15 or more Lams.				
Steepest Grain Sl.	Steepest Scarf Sl.	Working Stress	Steepest Grain Sl.	Steepest Scarf Sl.	Working Stress	Steepest Grain Sl.	Working Stress	Steepest Grain Sl.			
1:18	1:12	3000	1:18	1:12	2400	1:15	2500	1:15	200	450	1,800,000
1:18	1:12	2600	1:18	1:12	2100	1:15	2100	1:15	200	450	1,800,000
1:18	1:12	2600	1:18	1:12	2100	1:15	2100	1:15	200	450	1,800,000
1:18	1:12	3000	1:18	1:12	2400	1:15	2400	1:15	200	450	1,800,000
1:16	1:10	3000	1:18	1:12	2300	1:15	2400	1:15	200	450	1,800,000
1:18	1:12	2600	1:18	1:12	2100	1:15	2100	1:15	200	385	1,800,000
1:18	1:12	2600	1:18	1:12	2000	1:15	2000	1:15	200	450	1,800,000
1:18	1:12	2600	1:18	1:12	2000	1:15	2000	1:15	200	385	1,800,000
1:16	1:10	2600	1:18	1:12	2000	1:15	2000	1:15	200	385	1,800,000
1:14	1:8	3000	1:18	1:12	2200	1:14	2300	1:15	200	450	1,800,000
1:14	1:8	2600	1:18	1:12	1900	1:14	2000	1:15	200	450	1,800,000
1:14	1:8	2600	1:18	1:12	1900	1:14	2000	1:15	200	385	1,800 000

(are not normal.)

TENSION "t"					Compression Parallel to Grain "c"				Working Stress Shear Parallel to grain "H"	Working Stress Compression Perpendicular to grain "c.L"	Modulus of Elasticity "E"
Laminations		15 or more Laminations			4-14 Laminations		15 or more Lams.				
Steepest Grain Sl.	Steepest Scarf Sl.	Working Stress	Steepest Grain Sl.	Steepest Scarf Sl.	Working Stress	Steepest Grain Sl.	Working Stress	Steepest Grain Sl.			
1:18	1:12	2400	1:18	1:12	1800	1:15	1800	1:15	175	300	1,600,000
1:18	1:12	2000	1:18	1:12	1500	1:15	1500	1:15	175	300	1,600,000
1:18	1:12	2000	1:18	1:12	1500	1:15	1500	1:15	175	300	1,600,000
1:18	1:12	2400	1:18	1:12	1700	1:15	1700	1:15	175	300	1,600,000
1:16	1:10	2400	1:18	1:12	1700	1:15	1700	1:15	175	300	1,600,000
1:18	1:12	2000	1:18	1:12	1500	1:15	1500	1:15	175	260	1,600,000
1:18	1:12	2000	1:18	1:12	1500	1:15	1500	1:15	175	300	1,600,000
1:18	1:12	2000	1:18	1:12	1500	1:15	1500	1:15	175	260	1,600,000
1:18	1:12	2000	1:18	1:12	1400	1:15	1500	1:15	175	260	1,600,000
1:14	1:8	2400	1:18	1:12	1600	1:14	1700	1:15	175	300	1,600,000
1:14	1:8	2000	1:18	1:12	1400	1:15	1400	1:15	175	300	1,600,000
1:14	1:8	2000	1:18	1:12	1400	1:15	1400	1:15	175	260	1,600,000

For stress rating would not be justified. If in these combinations B&B quality is desired for one or both faces of a member to improve

### ***Fabrication — Continued***

43. Clamping may start at any point but shall progress to an end or ends.
44. The nailing of laminations in lieu of clamping for pressure shall not be permitted.



Laminated Rafters in farm construction.

### ***Vertical Laminations***

45. When vertically laminated beams are specified, the allowable stresses shall be the stresses specified in the Standard Grading Rules for the grade of lumber used.
46. Allowable stresses for vertically laminated beams made of combination grades of lumber shall be weighted average of the lumber grades.
47. All end joints shall be scarfed in vertically laminated beams to a slope not steeper than 1 in 8.
48. A lamination made up of two or more pieces in a vertically laminated beam shall be edge glued.

### ***Finished Sizes — Completed Members***

49. To the extent that other considerations will permit, the use of standard finished widths as shown constitutes recommended practice. These standard finished widths of members are based on the widths of lumber that can be used to best advantage for laminations and are as follows:

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Standard Finished Width (Net)	2¼"	3¼"	4¼"	5¼"	(or 5")	7"	9"	11"	12½"	14½"
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50. All members shall be trimmed to the lengths and finished to the width and depth dimensions specified.
51. Exceptions to these requirements for trimming and finishing apply to members specified to be pressure impregnated with preservatives, which may be trimmed and finished either at the fabricating plant or at the treating plant.

### ***Marking and Wrapping***

52. Each completed member shall be identified as to the manufacturer.
53. Each completed member shall be identified as to the principal stress involved and as to the stress rating for it.
54. Each completed member that is stressed principally in bending if significant to its proper use, shall be plainly marked to identify its top or bottom face.
55. Each completed member shall be marked "EXTERIOR" if exterior type of glue is used.
56. Each completed member shall have an approved end sealer applied to both ends after end trimming is performed at the point of fabrication.



Industrial building—9½ in. x 29 in. laminated beams on 40 ft. span.



### *Marking and Wrapping* — Continued

57. Each completed member shall be protected from damage such as would noticeably impair its appearance or lower its strength, durability or utility values. When method of shipment warrants such protection, a wrapping to enclose each completed member may be required.
58. Each completed member, if not pressure impregnated with a preservative and if the weather or other conditions justify, may be required to be enclosed in a moisture resistant wrapping or coating.



Railway Trestle — Laminated posts, caps and stringers.



Sections of 112 ft. span arches loaded for rail shipment.

## APPENDIX A

### SUPPLEMENTARY DESIGN PROVISIONS

- a. When a member is fully stressed by maximum design loads for many years, either continuously or cumulatively, use allowable stresses 90 per cent of those tabulated.
- b. Increase the tabulated stresses 15 per cent for 2 months maximum duration of full design load, 25 per cent for 7 days duration, 33-1/3 per cent for wind and earthquake, and 100 per cent for impact, but these increases are not cumulative.
- c. Occasional impact may be disregarded if the stress induced by it does not exceed the allowable stress for normal loading.

#### Curvature Factor

- d. Modulus of elasticity is a constant and none of the foregoing adjustments apply.
- e. For the curved portion of a member, the allowable stress in bending shall be multiplied by the curvature factor:

$$1 - 2000 \left( \frac{t}{R} \right)^2$$

in which

t is the thickness of lamination in inches and  
R is the radius of curvature of a lamination in inches,

and t/R shall not exceed 1/100. No curvature factor shall be applied to stress in the straight portion of a member regardless of curvature elsewhere.

#### Radial Tension or Compression

- f. The radial stress induced by a bending moment in a curved member shall be limited to the allowable stresses,  $S_R$ , when computed by the equation,

$$S_R = \frac{3M}{2Rbh}$$

where

M is the bending moment in inch pounds,  
R is the radius of curvature at center line of member in inches,  
b is the width of cross section in inches, and  
h is the height of cross section in inches.

- g. When M is in the direction tending to decrease curvature, (increase the radius), the stress is in tension and shall be limited to one-third the allowable stress in shear.
- h. When M is in the direction tending to increase curvature, (decrease radius), the stress is in compression and shall be limited to the allowable stress in compression perpendicular to the grain.

#### End Joints

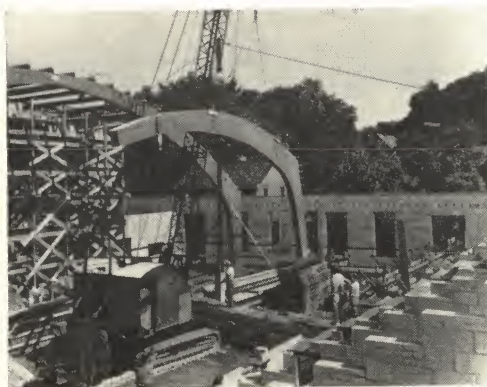
- i. When stepped scarf joints are specified, the portion of the thickness of the lamination occupied by the step is disregarded in computing the moment of inertia and/or the net effective area.



- j. Butt joints may be specified in the compression portion of the cross section of a member stressed principally in bending providing that all laminations at a single cross section having such joints are disregarded in computing the moment of inertia, and providing butt joints in adjacent laminations shall be spaced at least ten times the lamination thickness.
  - k. Butt joints may be specified in the tension portion of the cross section of a member stressed principally in bending, in which case the effective moment of inertia shall be computed by subtracting from the moment of inertia of the full cross section, 1.2 times the sum of the moments of inertia of those laminations containing butt joints at a single cross section, and butt joints in adjacent laminations shall be spaced at least ten times the lamination thickness.
  - l. In members curved to a radius less than 250 times the thickness of a lamination in the portion of laminations stressed to more than 60 per cent of allowable working stresses, scarf joints are required for the tension or compression portion of the cross section.
  - m. Butt joints may be used in compression members, in which case the effective cross-sectional area shall be computed by subtracting from the gross cross-sectional area, the area of all laminations containing butt joints at a single cross section. In addition, laminations adjacent to those containing butt joints and themselves containing butt joints, shall be considered only partially effective if the spacing in adjacent laminations is less than 50 times the lamination thickness. The effective area of such adjacent laminations shall be computed by multiplying their gross area by the following percentages:
- | Butt joint spacing<br>( $t$ =lamination thickness) | Effectiveness factor<br>(Per cent) |
|--|------------------------------------|
| 30 $t$   | 90                                 |
| 20 $t$   | 80                                 |
| 10 $t$   | 60                                 |
- n. Members stressed principally in bending with plain scarf joints not steeper than 1 in 5 require no modification of moment of inertia.
  - o. Compression members with plain scarf joints not steeper than 1 in 5 require no reduction in area.

### Fastenings

- p. The same allowable loads, stresses and methods of design for bolts, connectors and other fastenings apply to glued laminated members as to solid sawn members.



Erecting laminated arches. Relatively large cross-sectional area of laminated wood gives maximum resistance to twisting, buckling and other erection stresses.

## References

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